Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

AUGUST, 1916.

THE BEARING OF EARLY STONE IMPLEMENTS ON THE STAGES OF MAN'S PROGRESS.

By R. A. MARRIOTT.

GREAT advance has been made in correlating the implements of man in various parts of the world, and allowing certain stages of culture to be recognised as belonging to definite periods in geological sequence. However, everyone is agreed that the skill displayed in the oldest palaeoliths cannot mark man's first attempts to improve on nature.

Is there any trace of such early crude essays? Professor Prestwich was one of the first to advocate the claims of some flints collected from the North Down plateau by Mr. B. Harrison, of Ightham, to be classed as showing human work; but those who shared his opinion have been silenced by the onslaughts of well-known experts at home and in France who posed as authorities. These have declared them to be only natural products of earth-movements and percussion of flint against flint.

The controversy over the acceptance of the now recognised implements of the Old Stone age has been repeated in this case, following the usual course; but the opposition is weakening, and now one of its leaders has completely changed his views, so that we can infer that the eoliths, which have hitherto only been mentioned in either a contemptuous or apologetic manner, and in inverted commas, will soon take their proper place as the earliest known specimens of man's inventive genius.

This change of view is closely connected with the discoveries of Mr. J. Reid Moir of flint implements under the Crag of Suffolk. These, if admitted —and they practically are so—must involve the acceptance of the Ightham flints, which they resemble in some essentials, though exhibiting greater skill in their workmanship.

What is their exact *provenance* as regards geological periods it is difficult at present to decide, since from the detritus in which they are found they must be older even than their position would imply, and would have to be assigned to a date, as a minimum, out of all proportion to existing ideas on the subject of man's first appearance as *Homo sapiens*. This question of their age and place in geology has furnished the main prejudice with which they have been viewed.

It is not my purpose to dwell on these pre-Crag implements, which are fully described by Mr. J. Reid Moir,* and which have been the subject of much discussion, except in so far as they illustrate a certain evolution and a peculiar method of primary rough-hewing, which appears also in the implements to which I am going to refer.

The pre-Crag implements stand in a category *sui generis*, having an indirect relation to the Ightham eoliths; but there are other finds at Lewes collected by Mr. Harry Morris, showing close connection with these latter, in which the stages of evolution in flint manufacture are definitely portrayed in a most instructive manner. These define the very limited and primitive requirements of

* *Proceedings of Prehistoric Society, East Anglia*, Volume II, Part I.

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man at early stages, while at the same time they denote a very definite progress in these stages.

Certain features in the Lewes cultures also are observed to persist long after their original purpose became obsolete, showing that our progenitors, like ourselves, were conservative, and slow to depart from established methods and shapes long after they had become really unnecessary. Our own world is full of insignia of atrophied utilities.*

In the pre-Crag implements the persistence of a certain plane surviving through successive cultures has been demonstrated by Mr. Reid Moir; so, in these others, a knob, or handle, once useful in the pre-palaeolithic days, can be seen to continue in an atrophied condition through various cultures, ultimately dying away in the adze and in the well-known "scraper."

Of the Suffolk implements Mr. Moir writes as follows:—

"It appears to have been the custom of the pre-Crag people to fracture most of their flints by cleaving blows (the 'quartering' fracture of the Brandon 'Knappers), producing flat, non-conchoidal surfaces, and it is needless to impress upon any practical flint flaker the amount of practice and knowledge of flint which are necessary consistently to fracture flint in this manner

"The ancient workers, however, not only persistently adopted this method, but were able so accurately to guide the lines of cleavage produced by their blows that in many cases very little secondary work was needed. . . .

"This peculiar method of implement production is confined, as far as my knowledge goes, almost entirely to the pre-Crag period, and differentiates it from the work of any other epoch."

In view of these same flat non-conchoidal surfaces, many have been inclined to reject the view that the Lewes implements were human, and therefore the above statement is remarkably pertinent to the question. Sixty per cent. of them are struck flat in this way, and the remainder of the shaping blows are delivered on the other side, and in many cases "very little secondary work was needed."

Moreover, another instance of evolution is furnished in that through many forms with a flat base the well-known celt is at last evolved, but with a flat base also, indistinguishable on its worked side from the celts, which are a familiar feature of later cultures.

The collection contains so many hitherto unknown forms, though they are embryonic types of later instruments, that individual specimens convey no meaning to a casual glance, and the whole assemblage must be seen to be appreciated. For this reason, and because the method of flaking is also unknown, it would be useless to reproduce them in a few diagrams. I shall confine myself to mere outlines of the forms in a few cases, and give my deductions suggested by the forms regarding the mode of life of their makers.

Though it is merely an assumption which on the lines of evolutionary probability has been before advanced, it is made now with more certainty, as there is actual definite evidence to support it.

Man, in analogy with other creatures, had for his first care, after satisfying his hunger, that of preening himself to keep his body clean and healthy. He certainly was much more hairy than now. I do not know if the hairiness of the Ainos of Japan extends to their bodies. If so, they would be a survival; but certain crude and very primitive cave drawings suggest extreme hirsuteness.

Since hair is the lurking-place of unwelcome guests, and requires attention also after a day's foraging in the woods and bogs of the weald, a large proportion of his tools was made with a concave working surface to rub down his body and limbs. They were of all sizes—from larger ones for the body and legs to small ones to scrape the mud off the fingers and toes. These are outlined in Figures 129 and 130.

Figure 134 is reproduced to show that this kind of implement, with a concave surface for its objective, survived through much later cultures. Both stones are lustrous and without patina. The one on the right is of much earlier date, and retains most of the cortex on its reverse side. They could scarcely serve for any other purpose than limb-scraping.

Body-stones form part of the toilet requisites of the Patagonians to this day, and their use has been noted among other savage tribes by many well-known travellers.

The care of the feet must have been of especial importance to efficiency and comfort. Some implements seem evidently made for this purpose with a handle. The raspers, as I shall call them, are exceedingly well made, as shown in Figure 135, which includes a modern Egyptian rasper for the feet made of terra cotta (from Assiut). The similarity in outline is remarkable.

Native Australians and Patagonians use stones for this purpose. With the former they are called "bruisers," which denotes their application.† The callosities that the skin automatically produces on friction surfaces sometimes either crack or cause corns. A rubbing down by rasping is a well-known remedy for a cracked-skin surface, so that I need not elaborate this argument, but can take it for granted that such implements must have existed from the earliest times since man changed his arboreal habits and assumed the erect position.

Other implements, of which there are hundreds, are provided with a grip of two distinct kinds, instead of such a handle, and the grip in many cases seems to denote that they were intended for a planing action, so that the name "push-plane" would be appropriate in their case (see Figure 132).

* Compare the buttons over our coat-tails, or even our coat-tails themselves. Of what use are they?

† Their use also is noted in Borneo and South Africa.

These may also have been used as raspers, but there is an alternative suggestion that they were used for procuring fibre from plants, to which I shall refer presently.

Amongst the Ightham eoliths, so far as I am aware, there is nothing to show that their owners were flesh-eaters, but the indication is thenceforth, like the tiger, which has once tasted human flesh, he became dissatisfied with his former diet. The gradual change from an Arcadian-like existence to one of antagonism to his fellow-men, culminating in the present ferocious war, would, if it could be recorded, probably extend back to the first Glacial period of human times, and some

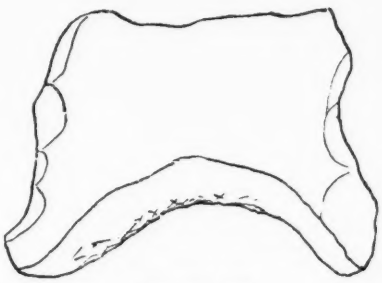

FIGURE 129.

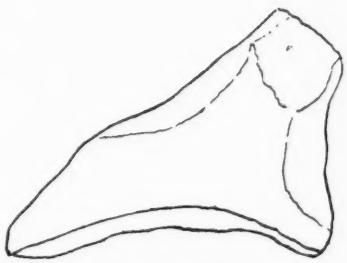

FIGURE 130.

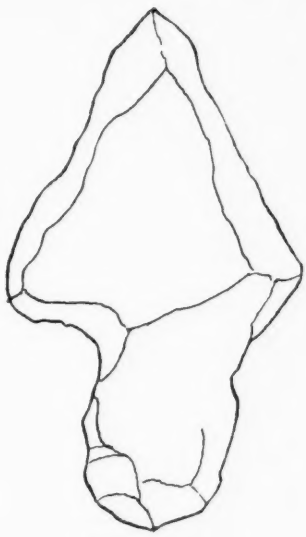

FIGURE 131.

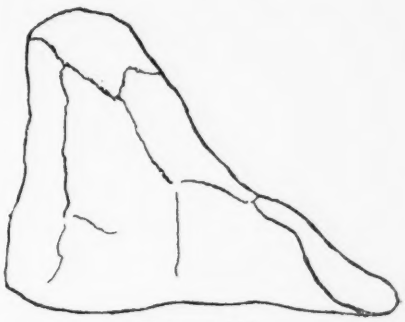

FIGURE 132.

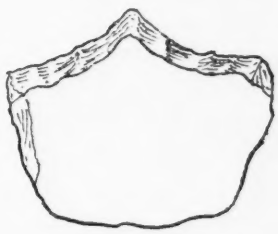

FIGURE 133.

Half-size, with the exception of Figure 133.

that their needs beyond these toilet requisites were confined to pointed stones to assist in grubbing up roots, truffles, pig-nuts, or their kind. The need for stones, where sticks could be procured, would hardly be urgent, and therefore the flints which seem to be made for this definite purpose as grubbers are rare, and they, I believe, only appear in this form in the Lewes cultures. They are T-shaped, with a broad grip and a blunt point like a dibble. There are also pounders of definite shape, such as would be used for crushing roots before maceration. Compare the cassava (manioc) of Africa, which is poisonous if this operation is omitted. Moreover, from the analogy of the primates, one would postulate early man as a vegetarian, as all the ape tribe now are.*

The truly pre-Glacial man, as we now know, was of the sub-tropical Mio-Pliocene age, and there appear to be no signs of weapons until the post-eolith Lewes cultures, when perhaps a glacial change of climate and the difficulty of procuring sufficient food in winter drove him to discover that the flesh of animals was also a nutrient, and of the eoliths I have seen are certainly strongly striated.

The first weapons appear in the Lewes finds. To our eyes they appear monstrosities, though they really are the rudiments of modern arrows, spears, and lances, but of such a weight, crudity, and bluntness that, on my showing some to a flint-arrow-head expert, I was met with the contemptuous remark, "Why! they are quite blunt!" As if the first attempts of man, without any standard of excellence that we have, and with only flint on flint, could be anything else! As a matter of fact, they were probably all that was wanted at close quarters with animals that had yet to learn fear of creatures that had never previously molested them. In the hands of a man with a large shoulder and arm development a thrust with such a weapon was quite sufficient for penetration (see Figure 131). When the wariness of the hunted increased, the spear gradually became a javelin, with greater lamination and of lighter build.

At this time traps also would come into use, marking the first step in man's conquest over time

* It is noteworthy that the sequence of creations in Genesis, which is so marvellously in accord with geology, if regarded as a visionary revelation, also implies in verse 29 that the first man (not Adam) was a vegetarian.

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and space. This is illustrated by certain trap-stones, similar in general shape and make to the spear-head, but of great size. One of these is twenty pounds in weight. Similar stones, but of later times evidently from their finished appearance, have been found in Scotland by the Rev. Frederick Smith, but have not yet received recognition, though we are not without examples of their use in the present day.*

The push-planes are sometimes of the pattern called "tea-cosy," but those like Figure 132, *i.e.*, with a grip for the fingers and with a flat instead of a concave working surface such as in Figure 130, largely predominate, and are from their uniform pattern evidently for a very definite purpose; but it is just these of which the utility is not so apparent. Let us see if the Ightham eoliths furnish a clue.

Amongst these latter, a various assemblage of chipped and flaked stones, one notices some that have a similar working surface, but with this difference, that the base (the objective) is struck often at an angle, so that the implement will not stand upright, while the push planes are all cut square. Further, the tea-cosy type is apparently absent at Ightham.

Now imagine a man whose whole interest, next to eating, was centred on his toilet. Would he not, in passing a flint over his limbs, prefer one with the working base set at an angle to the grip? This would certainly meet his requirements better than the push-planes.

I therefore think the flat base of the push-plane has another use. I suggest that it was introduced later, since the bases set at an angle are of cruder form and less numerous.

Flesh-eating required hunting, and hunting weapons of offence, and fibre was wanted to attach the weapon to the haft Now this implement, with its sharp, untrimmed edge, is admirably adapted for removing the parenchyma and extracting fibre from plants, as experiment has proved. Thongs of skin would not at first suggest themselves, and this idea receives support from the absence of skin-scrapers from the Lewes finds.

The apparent absence of any such flat bases of the push-plane type among the Ightham flints points, as does the lack of spear-heads, to the introduction of these adjuncts at a later date, and to the sub-tropical conditions of eolithic times, when there was abundance of vegetable diet throughout the year.

Flints fashioned for boring small holes need not be described, as such appear in later cultures; but certain obtuse-angled chipped surfaces on flat oval-shaped flints must be noticed, as they can be assigned to a definite cleaning purpose, and form a large portion of the Ightham flints. If given a name, they might best be styled as rectal flints (see Figure (133).

There is evidence of the use of these stones in many parts of the world, and was first brought to notice by Professor Rupert Jones, writing on the Burmese finds in Mio-Pliocene strata in *Natural Science*, 1894. They are also said to be used in the extreme West of Ireland.

The following account was given me by Mr. Harrison of a statement made by a Burmese student who was brought to see these flints at his own wish after hearing of them in 1912. Mr. Maung said he had seen in Burmah, amongst people called "Palaungs," similar stones, and that, so far as he could judge, they were chipped or handworked. They were of a shape generally approaching triangular, and he knew they were used for this purpose. Also they were used by persons who perform religious ceremonies, and are placed on one side, and then washed as an act of merit by others (devotees), much in the same way that prayer-wheels are used. To have found a purpose for such roughly shaped flints is of fundamental importance to the whole series of the eoliths collected by Mr. Harrison.

I have remarked on the unusual flaking of the Lewes flints, which, though they constantly exhibit secondary work, at once prejudice those acquainted with the usual forms. When met by the remark, "I see no human flaking here!" one can only retort, "If not of man, it is certainly neither the work of nature on flints such as they are to-day." If flints go through a process of silicification, beginning with a "colloid" or viscous form of silica, and are also more easily worked when freshly extracted from their matrix, why not admit the possibility of these flints having been worked when in a less advanced flinty condition, to attain the acquired hardness after flaking and exposure?

The assumption obtains some support from the fact that at a certain stage of culture in the Lewes finds these same shapes are struck with bulbs of percussion, which are of a nature to stamp them as undoubtedly human, but being at the time a new method produced tools seemingly inferior to those struck and flaked in the former "impossible" manner.

In dealing with these I have attempted to answer a question that has constantly been asked: Of what possible use could these strange shapes be? If that question has been only partly and imperfectly answered, it may, I hope, form a framework of ideas which workers in the field can correct or verify by the assistance of such sidelights as I have been able to give.

Many of the implements acquire additional interest from their close connection with the Piltdown skull, the derivation of which is from the same deposit of Pliocene date.

* Large stones are, I am told, used now in Devonshire to secure rabbits by their fall.

FIGURE 134. Tools with concave working surfaces for rubbing down the body.

FIGURE 135. Raspers for the feet.

The upper specimen is a modern Egyptian example made of terra cotta.

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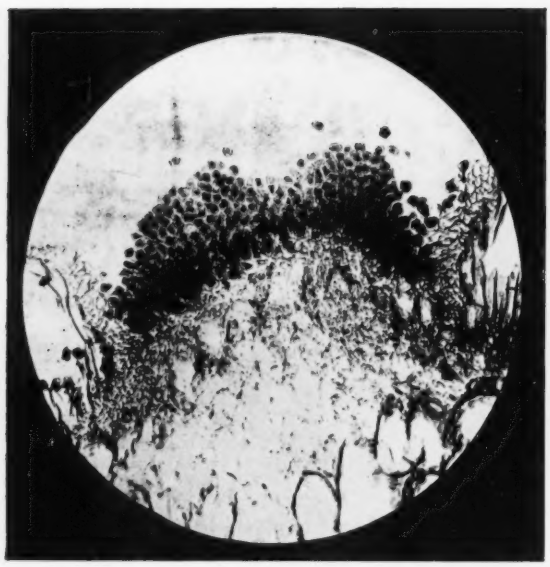

FIGURE 136. *Coeoma Mercurialis.*

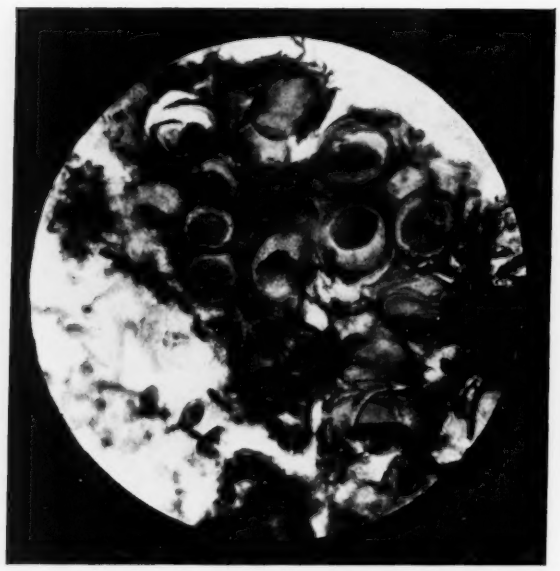

FIGURE 138. *Synchytrium* in Potato.

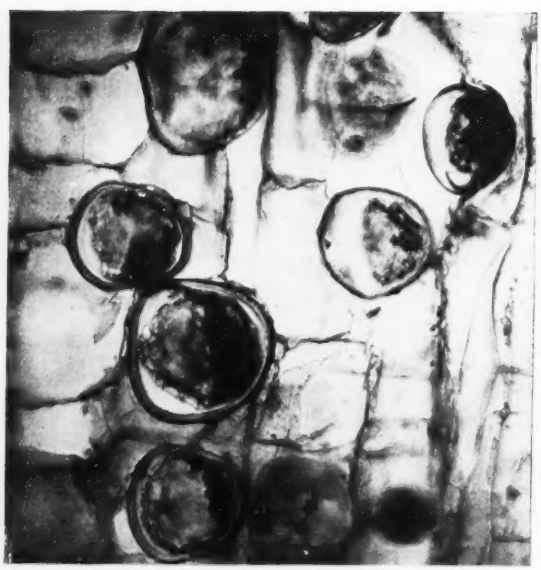

FIGURE 137. *Protomyces* on *Aegopodium.*

FIGURE 139. *Melanotaenium* on *Galium.*

Parasitic Fungi (see Pages 165 and 166).

THE FACE OF THE SKY FOR SEPTEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 39.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Sept. 2.....	10 44·9	N. 8·0	14 6·9	S. 18·3	12 17·9	S. 3·6	7 41·7	N. 18·0	2 14·0	N. 11·9	7 53·7	N. 20·8	21 18·1	S. 16·5	8 24·0	N. 19·1
„ 7.....	11 2·9	6·1	19 6·0	S. 23 8	12 37·8	6·5	8 0·7	17·7	2 13·3	11·9	7 55·9	20·8	21 17·4	16·5	8 24·7	19·0
„ 12.....	11 20·9	4·2	23 45·7	N. 3·3	12 54·2	9·0	8 20·6	17·1	2 12·4	11·8	7 58·0	20·7	21 16·8	16·6	8 25·3	19·0
„ 17.....	11 38·9	2·3	4 8·4	N. 25·1	13 5·9	10·8	8 41·0	16·4	2 11·1	11·6	7 59·9	20·6	21 16·2	16·6	8 25·8	19·0
„ 22.....	11 56·8	N. 0·3	8 27·1	N. 18·5	13 10·7	11·6	9 2·0	15·5	2 9·5	11·5	8 1·8	20·5	21 15·7	16·7	8 26·3	19·0
„ 27.....	12 14·8	S. 1·6	12 15·4	S. 6·8	13 6·1	S. 11·0	9 23·3	N. 14·3	2 7·7	N. 11·3	8 3·5	N. 20·4	21 15·2	S. 16·7	8 26·8	N. 18·9

TABLE 40.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon. P
	°	°	°	°	°	°	°	h. m.	h. m.	°
Sept. 2 ...	+21·5	+7·2	318·3	Sept. 4 ...	−20·5	+3·3	298·6	286·5	3 50 *m*	4 5 *m*	Sept. 2	+18·6
„ 7 ...	22·7	7·3	252·3	„ 11 ...	20·6	3·3	324·6	259·1	3 7 *m*	4 50 *m*	„ 7	− 7·9
„ 12 ...	23·7	7·2	186·3	„ 18 ...	20·7	3·3	350·8	231·8	2 24 *m*	5 36 *m*	„ 12	−23·0
„ 17 ...	24·6	7·2	120·3	„ 25 ...	−20·9	+3·3	17·0	204·6	1 41 *m*	6 21 *m*	„ 17	− 9·4
„ 22 ...	25·3	7·0	54·3								„ 22	+14·1
„ 27 ...	+25·8	+6·8	348·3								„ 27	+22·8

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The data for the Moon in Table 40 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving rapidly Southward, and crosses the Equator on 23rd at 9^h *m*, when autumn begins. Its semi-diameter increases from 15′ 53″ to 16′ 0″. Sunrise changes from $5^h\ 13^m$ to $5^h\ 59^m$; sunset from $6^h\ 48^m$ to $5^h\ 41^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening star, fairly well placed for observation. It reaches elongation, 27° East of Sun, on 9th. Semi-diameter increases from 3″ to 5″. Illumination $\frac{3}{4}$ at beginning of month, $\frac{1}{10}$ at end.

VENUS is a morning star, well placed for observation. At elongation, 46° West of Sun on 12th. Near Moon on morning of 23rd. The semi-diameter diminishes from 13½″ to 10″. Illumination of disc increases from $\frac{6}{7}$ to $\frac{8}{8}$.

THE MOON.—First quarter $5^d\ 4^h\ 26^m$ *m*; Full $11^d\ 8^h\ 31^m$ *e*; Last quarter $19^d\ 5^h\ 35^m$ *m*. New $27^d\ 7^h\ 34^m$ *m*. Perigee $9^d\ 1^h$ *e*. Apogee $21^d\ 10^h$ *m*. Semi-diameter 16′ 28″, 14′ 47″ respectively. Maximum librations 1^d 7° N., 2^d 6° E., 14^d 7° S., 15^d 7° W., 28^d 5° E., 29^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 43.)

MARS is low in the West and badly placed for observation.

JUPITER is a morning star in Aries; it has begun to retrograde, and reaches opposition on October 24th. Equatorial diameter 48″, Polar 45″. Defect of illumination 0″·3.

Configuration of satellites at $0^h\ 15^m$ *m* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Sept. 1		○ 2134	Sept. 16	21 ○	34
„ 2	21 ○	34	„ 17	2 ○	314
„ 3	23 ○	14	„ 18	31 ○	24
„ 4	31 ○	42	„ 19	3 ○	214
„ 5	342 ⊙		„ 20	32 ○	4 1●
„ 6	423 ○	1	„ 21	41 ○	23
„ 7	41 ○	23	„ 22	4 ○	123
„ 8	4 ○	123	„ 23	412 ○	3
„ 9	421 ○	3	„ 24	42 ○	31
„ 10	42 ○	31	„ 25	431 ○	2
„ 11	431 ○	2	„ 26	43 ○	21
„ 12	34 ⊙	1	„ 27	4321 ○	
„ 13	23 ○	4 1●	„ 28	4 ⊙	3 2●
„ 14	1 ○	234	„ 29	4 ○	123
„ 15		○ 1234	„ 30	12 ○	43

The following satellite phenomena are visible at Greenwich:—$2^d\ 11^h\ 10^m$ *e* III. Tr. I.; $3^d\ 0^h\ 11^m$ *m* III. Tr. E., $0^h\ 27^m\ 48^s$ *m* II. Ec. D., $3^h\ 54^m$ I. Sh. I., $5^h\ 1^m$ *m* I. Tr. I., $5^h\ 14^m$ *m* II. Oc. R.; $4^d\ 1^h\ 3^m\ 41^s$ *m* I. Ec. D., $4^h\ 21^m$ *m* I. Oc. R., $9^h\ 12^m$ *e* II. Tr. I., $9^h\ 29^m$ *e* II. Sh. E., $10^h\ 22^m$ *e* I. Sh. I., $11^h\ 28^m$ *e* I. Tr. I., $11^h\ 40^m$ *e* II. Tr. E.; $5^d\ 0^h\ 32^m$ *m* I. Sh. E., $1^h\ 35^m$ *m* I. Tr. E., $10^h\ 48^m$ *e* I. Oc. R.; $9^d\ 10^h\ 8^m$ *e* III. Sh. I.; $10^d\ 0^h\ 2^m$ *m* III. Sh. E., $2^h\ 45^m$ *m* III. Tr. I., $3^h\ 2^m\ 30^s$ *m* II. Ec. D., $3^h\ 42^m$ *m* III. Tr. E.;

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TABLE 41. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Geminorum	7 2 14	+22 51	6·6 to 13·2	370	1916—Oct. 2
V Ursae Min.	13 37 10	+74 45	7·5 to 8·7	71	,, Sept. 26
RU Herculis	16 6 41	+25 17	7·0 to 14·2	483	,, Sept. 10
X Ophiuchi	18 34 17	+ 8 46	6·5 to 9·5	335	,, Sept. 14
AF Cygni	19 27 40	+45 58	6·9 to 8·0	99	,, Sept. 3
Z Cygni	19 59 3	+49 48	7·1 to 13·8	263	,, Sept. 27

Minima of Algol $5^d\ 4^h\cdot6\ m$, $8^d\ 1^h\cdot4\ m$, $10^d\ 10^h\cdot2\ e$, $13^d\ 7^h\cdot0\ e$, $28^d\ 3^h\cdot1\ m$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $7^d\ 3^h\cdot7\ e$, $20^d\ 1^h\cdot8\ e$. Period $12^d\ 22^h\cdot1$.

$11^d\ 2^h\ 58^m\ 8^s\ m$ I. Ec. D., $9^h\ 30^m\ e$ II. Sh. I., $11^h\ 35^m\ e$ II. Tr. I.; $12^d\ 0^h\ 6^m\ m$ II. Sh. E., $0^h\ 16^m\ m$ I. Sh. I., $1^h\ 15^m\ m$ I. Tr. I., $2^h\ 3^m\ m$ II. Tr. E., $2^h\ 25^m\ m$ I. Sh. E., $3^h\ 22^m\ m$ I. Tr. E., $9^h\ 26^m\ 47^s\ e$ I. Ec. D.; $13^d\ 0^h\ 36^m\ m$ I. Oc. R., $7^h\ 42^m\ e$ I. Tr. I., $8^h\ 45^m\ e$ II. Oc. R., $8^h\ 54^m\ e$ I. Sh. E., $9^h\ 49^m\ e$ I. Tr. E.; $17^d\ 2^h\ 9^m\ m$ III. Sh. I., $4^h\ 2^m\ m$ III. Sh. E., $5^h\ 37^m\ 14^s\ m$ II. Ec. D., $18^d\ 4^h\ 52^m\ 41^s\ m$ I. Ec. D.; $19^d\ 0^h\ 8^m\ m$ II. Sh. I., $1^h\ 56^m\ m$ II. Tr. I., $2^h\ 10^m\ m$ I. Sh. I., $2^h\ 44^m\ m$ II. Sh. E., $3^h\ 1^m\ m$ I. Tr. I., $4^h\ 19^m\ m$ I. Sh. E., $4^h\ 25^m\ m$ II. Tr. E., $5^h\ 8^m\ m$ I. Tr. E., $11^h\ 21^m\ 23^s\ e$ I. Ec. D.; $20^d\ 2^h\ 22^m\ m$ I. Oc. R., $7^h\ 50^m\ e$ III. Oc. D., $8^h\ 38^m\ e$ I. Sh. I., $8^h\ 47^m\ e$ III. Oc. R., $9^h\ 28^m\ e$ I. Tr. I., $10^h\ 48^m\ e$ I. Sh. E., $11^h\ 3^m\ e$ II. Oc. R., $11^h\ 35^m\ e$ I. Tr. E.; $21^d\ 8^h\ 48^m\ e$ I. Oc. R.; $26^d\ 2^h\ 45^m\ m$ II. Sh. I., $4^h\ 3^m\ m$ I. Sh. I., $4^h\ 16^m\ m$ II. Tr. I., $4^h\ 46^m\ m$ I. Tr. I., $5^h\ 22^m\ m$ II. Sh. E.; $27^d\ 1^h\ 16^m\ 3^s\ m$ I. Ec. D., $4^h\ 7^m\ m$ I. Oc. R., $8^h\ 3^m\ 34^s\ e$ III. Ec. D., $9^h\ 29^m\ 24^s\ e$ II. Ec. D., $9^h\ 57^m\ 14^s\ e$ III. Ec. R., $10^h\ 32^m\ e$ I. Sh. I., $11^h\ 12^m\ e$ I. Tr. I., $11^h\ 14^m\ e$ III. Oc. D.; $28^d\ 0^h\ 10^m\ m$ III. Oc. R., $0^h\ 42^m\ m$ I. Sh. E., $1^h\ 19^m\ m$ II. Oc. R., $1^h\ 20^m\ m$ I. Tr. E., $7^h\ 44^m\ 40^s\ e$ I. Ec. D., $10^h\ 34^m\ e$ I. Oc. R.; $29^d\ 6^h\ 41^m\ e$ II. Sh. E., $7^h\ 10^m\ e$ I. Sh. E., $7^h\ 46^m\ e$ I. Tr. E., $7^h\ 54^m\ e$ II. Tr. E. Eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

SATURN becomes visible as a morning star in Cancer, having been in conjunction with Sun on July 12th. Polar semi-diameter 8″. Major axis of ring 39″, Minor 14″.

East Elongations of Tethys (every fourth given) $17^d\ 11^h\cdot1\ e$, $25^d\ 0^h\cdot4\ e$; of Dione (every third given) $19^d\ 6^h\cdot3\ e$, $27^d\ 11^h\cdot5\ e$; of Rhea (every second given) $18^d\ 1^h\cdot8\ m$, $27^d\ 2^h\cdot9\ m$. For Titan and Japetus E., W. denote East and West Elongations; S., I. Superior and Inferior Conjunctions. Titan $18^d\ 3^h\cdot0\ m$ E., $25^d\ 8^h\cdot3\ e$ W. Japetus 13^d W., Oct. $2^d\ 11^h\cdot9\ e$ S.

URANUS was in opposition on August 10th. It is in Capricornus. Semi-diameter 1″·8.

NEPTUNE becomes visible as a morning star in Cancer, having been in conjunction with Sun on July 25th. 2° North of Venus on 13th.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s\cdot83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 42.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
June–Sept. ...	335	+ 57	Swift.
July 25–Sept. 15	48	+ 43	Swift, streaks.
July–Oct. ...	355	+ 72	Swift, short.
Aug.–Sept. ...	353	− 11	Rather slow.
Aug.–Sept. ...	346	0	Slow.
Aug.–Oct. 2 ...	74	+ 42	Swift, streaks.
Aug.–Sept. ...	63	+ 22	Swift, streaks.
Sept. 4–20 ...	346	0	Slow.
,, 5–15 ...	62	+ 37	Swift, streaks.
,, 6–17 ...	106	+ 52	Swift, streaks.
,, 10 ...	74	+ 41	Swift, streaks.
,, 15 ...	77	+ 57	Swift, streaks.
,, 21 ...	31	+ 19	Slow.
,, 22 ...	335	+ 58	Slow.
,, 27 ...	75	+ 15	Swift, streaks.

TABLE 42.

Day.	Vega. N. Dec. 38° 42′.	β Capricorni. S. Dec. 15° 3′.	α Aquarii. S. Dec. 0° 43′.
	h. m. s.	h. m. s.	h. m. s.
Aug. 27	8 11 14·78 e	9 53 11·59 e	11 38 4·57 e
Sept. 6	7 31 55·49 e	9 13 52·45 e	10 58 45·52 e
,, 16	6 52 36·17 e	8 34 33·27 e	10 19 26·43 e
,, 26	6 13 16·86 e	7 55 14·08 e	9 40 7·32 e

SUN before clock September 1st, $0^s\cdot95$; September 6, $98^s\cdot31$; September 11, $201^s\cdot31$; September 16, $307^s\cdot26$; September 21, $413^s\cdot33$; September 26, $516^s\cdot99$; October 1, $615^s\cdot94$. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near August, 1916, are included. The lists in recent months may also be consulted. (See Table 41.)

TABLE 43. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1916.			h. m.	°	h. m.	°
Sept. 9 ...	υ Capricorni	5·3	0 2 *m*	26	0 53 *m*	278
„ 9 ...	BD −14°·6039	7·0	7 14 *e*	94	—	—
„ 10 ...	BD −8°·5873	7·0	8 34 *e*	46	—	—
„ 10 ...	186 B Aquarii	6·1	11 37 *e*	36	0 41**m*	257
„ 15 ...	47 B Arietis	6·5	4 7 *m*	29	5 5 *m*	286
„ 16 ...	ϵ Arietis (double)	4·6	2 22 *m*	102	3 23 *m*	210
„ 16 ...	WZC 176	6·7	—	—	3 29 *m*	278
„ 17 ...	WZC 228	6·6	—	—	0 48 *m*	253
„ 17 ...	BAC 1186	6·4	—	—	0 53 *m*	201
„ 17 ...	27 Tauri	3·7	0 4 *m*	30	0 55 *m*	292
„ 17 ...	28 Tauri	5·2	0 24 *m*	358	0 44 *m*	324
„ 17 ...	BD+23°·569	6·8	—	—	1 16 *m*	234
„ 17 ...	BD+24°·674	6·8	—	—	10 49 *e*	267
„ 19 ...	BD+25°·941	6·8	—	—	3 27 *m*	186
„ 20 ...	52 B Geminorum	6·5	3 12 *m*	72	4 24 *m*	295
„ 21 ...	BD+22°·1687	6·7	—	—	3 52 *m*	261

The asterisk indicates the day following that given in the date column.

From New to Full Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

NOTE.—I continue to use Greenwich Mean Time, as this is more suitable for use in astronomical records. To convert into Summer Time, add one hour to all times given above. For example the occultation disappearance of ϵ Arietis occurs at $3^h\ 22^m$ *m* Summer Time.

CORRESPONDENCE.

ROCK STRUCTURES AND PRIORITY.

To the Editors of "KNOWLEDGE."

SIRS,—I notice a correspondent, "R. H. R.," on page 122 of your June issue, in speaking of "Structures in Sedimentary Rocks," states: "One of the pioneers in this kind of work was Professor Bonney, who was President of the Geological Section of the British Association at Birmingham in 1886. In his presidential address he gave a most interesting summary of the then state of our knowledge on the subject, chiefly based on a study of thin slices of the rocks. The late Dr. Sorby, of Sheffield, also did a good deal of work on the sedimentary rocks." With all due respect to Professor Bonney, we think that even that gentleman will consider that your correspondent has put the cart before the horse, to use an expression familiar to Professor Bonney. Surely the late Dr. Sorby was the pioneer in these matters. In the very address by Professor Bonney to which your correspondent refers this would appear to be borne out, judging by the following extract: "Once for all, I ask you to bear in mind that this address is mainly a recital of other men's work, so that I shall not need to interrupt its continuity by remarks as to the original observers. The subject is, indeed, one to which I have paid some attention, but I can only call myself a humble follower of such good men as Godwin-Austin—'the physical geographer of bygone periods'—and Sorby, *who was the first to apply the microscope to similar problems*, and to whom in this class of investigation we need only apply the well-known saying, '*Nihil tetigit quod non ornavit.*'"

T. S.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

SIZE OF THE PUPIL OF THE EYE.—This is a matter of importance in telescopic observations, as it comes into the calculation of the lowest power that can be used with advantage on very faint objects. Some textbooks give the breadth of the pupil as one-fifth of an inch. This, however, is the value in daylight, and the pupil gets larger in a dim light. Mr. Steavenson described, at the meeting of the British Astronomical Association on June 28th, an ingenious method of determining the value in the latter conditions. He took several photographs, by magnesium flash, of eyes that had been in a subdued light for some time. The flash is so rapid that the contraction of the pupil can scarcely be noticeable during the time of exposure. The mean of the results for several eyes was just one-third of an inch, the different eyes giving accordant values. Hence the lowest power than can be used without loss of light is three times the aperture in inches. For the great Rosse reflector this gives a power of 216. It was pointed out at the meeting that the lowest power actually used was much less than this, and consequently that it only admitted light from a small part of the mirror to the eye. The calculation applies only to faint objects like comets and nebulae, for bright objects like the Moon and planets would cause the pupil to contract. However, it is just for these faint objects that one desires a low power, to obtain a large field of view and greater contrast. For example, a power of 12 may be used on a four-inch for comets and nebulae. This is much less than the lowest power usually employed.

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PLANETARY ALBEDOES.—The determination of the albedo, or reflecting power, of the surfaces of the different orbs in our system, is of great interest, as it is of help in determining their physical condition. Professor H. N. Russell contributed an article on the subject to *The Astrophysical Journal* for March, in which he collects the most reliable determinations. He states that the full Moon is 8·7 times brighter than the first quarter; 10·0 than the last quarter. The visual stellar magnitude of the Sun is −26·72; the photographic, −25·93. The colour index is therefore $0^m \cdot 79$, in good agreement with the mean value ($0^m \cdot 72$) for stars of G, or solar, type.

The following table gives some of his data for the Moon and planets. The stellar magnitudes of the Moon and superior planets are for mean opposition; those of Mercury and Venus for mean distance from Sun, unit distance from Earth.

Object.	Magnitude.	Visual Albedo.	Photographic Albedo.	Colour Index.
Moon ...	−12·55	0·07	0·05	+1·18
Mercury ...	− 2·5	0·06	—	—
Venus ...	− 4·77	0·59	0·60	+0·78
Mars ...	− 1·85	0·15	0·09	+1·38
Jupiter ...	− 2·29	0·56	0·73	+0·50
Saturn ...	+ 0·89	0·63	0·47	+1·12
Uranus ...	+ 5·74	0·63	—	—
Neptune ...	+ 7·65	0·73	—	—

The low albedo of Mercury supports the conclusion that it has practically no atmosphere. Mars has a thin atmosphere and a somewhat higher albedo. Its large colour index is due to the red colour of its soil. According to the above data, seven hundred thousand full Moons would be required to give as much light as the Sun.

Professor Very's value of the Earth's albedo, 0·89 (derived from the brightness of earthshine on the Moon), is rediscussed in another manner, and the value (0·49) deduced. We may conclude that it does not differ markedly from the albedo of Venus. The albedoes of the four giant planets are all high, owing to their cloud-laden atmospheres. The light of Saturn would appear to be redder than that of Jupiter from its high colour index.

THE LARGEST PROPER MOTION KNOWN.—The well-known star Groombridge, 1830 (annual motion 7″·04), headed the list of proper-motion stars till 1897, when Kapteyn, Gill, and Innes discovered that the southern star C.Z.C. $5^h \cdot 243$ had an annual motion of 8″·70. A still larger motion, exceeding 10″ per annum, has now been found by Professor Barnard. *Bulletin* 613 of Harvard College Observatory runs as follows: "Professor Edwin B. Frost, Director of the Yerkes Observatory, writes: 'From a comparison of his photographs taken with the ten-inch Bruce telescope, with the aid of the Zeiss Blink-mikroscop, Professor Barnard has just discovered a star of the eleventh magnitude, having the remarkable annual proper motion of about 10″. . . . The star is shown on several plates, one taken as far back as 1894, August 24th, with the six-inch Willard lens at the Lick Observatory. The motion is almost directly north.' This motion is confirmed by numerous Harvard photographs, the first of which were taken on May 22nd, 1888, and August 8th, 1890.—EDWARD C. PICKERING."

This star, though of the eleventh magnitude photographically, is at least as bright as 9·4 visually (on the B.D. scale), and hence is readily visible in small telescopes.

I have prepared a chart showing the surrounding stars, and the position of the Barnard star in 1898 (from a Toulouse chart), at the present time, and predicted approximately for 1934, 1952, 1970. The proximity of the star BD+4°·3560 (marked *c* on the chart) will make the change of place easy to detect in a year or two. The star is distant 36′ from 66 Ophiuchi, and is therefore in the same field with low powers. It must have been very near star *d* about 1842, and it is possible that an observation made at Munich in July, 1842, which has hitherto been supposed to refer to star *d*, really refers to Barnard's star. I give the observed position reduced to the equinox of 1916·0; also two later Munich observations which certainly refer to star *d*.

Star.	R.A. (Eqx. of 1916·0).	N.Dec. (Eqx. of 1916·0).	Date of Observation.
	h. m. s.	° ′ ″	
Doubtful whether *d* or Barnard's Star	17 53 46·92	4 15 12·4	1842·56
d	17 53 46·38	4 15 28·8	1886, July 18
d	17 53 46·72	4 15 22·1	1886, Aug. 12

The star is likely to prove one of our near neighbours, and curiosity will be felt as to the determination of its parallax, which will doubtless be made as soon as possible.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

COMPOSITION OF ANCIENT RUSSIAN OAK.—Large quantities of oak are obtained from the old bed of the river Moksha, in Central Russia, where the trees lie buried in soil and silted sand. It is estimated that the wood must be one thousand years old, but it is so well preserved that it is used for the same purposes as ordinary oak. Specimens of this oak recently introduced into England have been examined by Mr. P. Ellis Richards, more particularly with the object of ascertaining the effect of the long contact with moist sand upon the mineral constituents (*Analyst*, 1916, XLI, 169).

The colour of these specimens was grey or dull brown to black, and they still showed the original fibrous texture. Compared with a specimen of English oak they had the following composition:—

	Russian Oak. Grey. Per cent.	Black. Per cent.	English Oak. Per cent.
Mineral matter	1·12	2·21 ...	0·49
Extracted by ether and alcohol.....	3·26	2·51 ...	8·23
Water and total extract	39·7	47·4 ...	39·9
Cellulose	33·6	31·0 ...	34·6
Lignin, etc.	26·7	21·6 ...	25·5

The ash from the Russian specimens contained 49·73 and 69·45 per cent. of iron oxide, while the ash of the English wood contained only 6·48 per cent. The general conclusion drawn by Mr. Richards is that the high percentage of iron must be attributed to the long contact of the wood with a sandy soil rich in iron. The salts of potassium and sodium originally present have to a large extent been replaced by calcium in the same manner, though the wood has otherwise retained much of its original character.

POTASH IN BANANA SKINS.—Mr. R. H. Ellis calls attention to the large proportion of potash contained in banana skins and stalks (*Journ. Soc. Chem. Ind.*, 1916, XXXV, 456, 521). Analysis of the stalks, containing 91·60 per cent. of water, gave 2·40 per cent. of ash, of which 45·90 per cent. consisted of potash; while the skins (with 88·20 per cent. of water) yielded 1·77 per cent. of ash, containing 57·16 per cent. of potash.

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Thus a ton of banana stalks would yield fifty-four pounds of ash, while the total quantity of stalks annually imported into this country (sixteen thousand tons) would yield upwards of eighteen tons of potash. Again, it is estimated that the quantity of bananas annually imported into England would yield about sixty thousand tons of skins, or seven thousand one hundred and twelve tons of dry substance, containing about nine per cent. of potash. In view of the present scarcity of potassium salts this source of supply could be profitably utilised.

ACTION OF ANILINE DYES ON PROTEINS.—A curious property of certain aniline dyestuffs has been discovered by M. A. C. Hollande (*Comptes Rendus*, 1916, CLXII, 959). On adding basic dyestuffs to blood serum, or similar albuminous sera, a copious precipitate is produced; but if an acid dyestuff such as Congo Red be used coagulation of the albumin is prevented. By adding only just sufficient dyestuff to prevent coagulation of the serum when heated the liquid solidifies to a transparent jelly when cold. Definite compounds between the soluble proteins and the dyestuffs appear to be produced. These compounds are not precipitated by cold alcohol, nitric acid, or formalin, but they can be "salted out" by saturating the liquid with ammonium sulphate. The specific nature of proteins is modified by boiling the liquid containing them with an acid dyestuff. For example, repeated injection into a rabbit of a solution of egg albumin which had been boiled for ten minutes with Congo Red did not produce in the serum of the rabbit precipitines specific for egg albumin. Sera thus mixed with a suitable proportion of an acid dyestuff may be sterilised in an autoclave at 120° C., and the jelly which forms when the mixture cools may be used as a culture medium in bacteriological work.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.Sc.

VULCANOLOGY.—The latest number (Volume II, Part 3) of the recently instituted *Zeitschrift für Vulkanologie*, which has come to hand, contains several interesting studies on volcanic activity. K. von Komorowicz describes in detail the various types of structures which are found in North Celebes. Soepoetan, the chief volcano, resembles the Pico de Teyde, and consists of two cones and a large depression filled with recent lava. The older cone, which reaches a height of one thousand nine hundred metres and has been quiescent for some time, has been formed by the piling-up of scoria, lapilli, and ashes, bombs being rare, while the younger cone, which is one thousand five hundred metres high, and has been active recently, belongs to the Stromboli type, and is composed of loose scoria. The latter cone is not parasitic, but has been formed through the blocking of the pipe of the former by a mass of solidified lava. The lava-field resembles those of Iceland, while there are also some small craters belonging to the type prevalent in the latter island.

The other types include several surface craters lying on a plateau, a long fissure flanked by ridges of ash and a crater which has undergone partial erosion, and is now in the form of a horse-shoe. The products of the recent activity are partly semiplastic material, resembling the so-called "lavablockströme," and partly crumbling, very vesicular pumice.

H. Simotomai reviews the eruptions during the last century of the volcanoes of the Fuji and Kirishima zones in Japan, and gives a description of the cauldron of Kutscharo. The latter depression is about twenty-eight kilometres in diameter, and, except for an opening in the south-east side, is surrounded by walls rising to a height of one thousand metres. It seems to have been formed by the foundering of volcanic agglomerate, and contains several fumaroles, from which large amounts of sulphur—four hundred and fifty tons annually—are obtained.

J. F. Tristan gives a note on some recent outbreaks of the "Poás" volcano in Costa Rica. These consisted mainly of eruptions of mud and steam, the activity resembling that of an immense geyser. The characteristic forms which the ejected mud assumes are shown in some very fine photographs. The most noteworthy consists of a mass of radiating pillars, nearly vertical, and rising to a height of one hundred and seventy-five metres.

NIGHT MARCHING BY STARS.—An admirable article by E. A. Reeves in *The Geographical Journal* (Jun , 1916) gives an account of the various methods of using the stars for determining direction at night. These, of course, are intended to be supplementary to the use of the compass, and need only be used when the latter is not available or as often happens in basaltic countries, unreliable. For the approximate determination of direction all that is necessary is the ability to identify some bright stars and a knowledge of their bearings. Obviously the star must have a low altitude, as it is impossible to determine a direction from those near the zenith. For more accurate work various devices are in use. Thus Colonel Tilney has prepared tables giving the azimuths of a number of stars for every five degrees of latitude and each hour of night; and, provided the latter are known, the bearing of the star is given immediately. Reeves has also devised a "night-marching watch," which can be used for determining direction in a way similar to that in which a watch may be used in the daytime. The azimuth can also be found from the measured altitude, and a modified clinometer by means of which the latter can be determined has been devised. A slightly more elaborate instrument, "the astronomical compass," gives both altitude and azimuth without the assistance of tables. Provided a suitable star is chosen, and its bearing is not assumed constant for more than fifteen minutes, no difficulties arise in the use of these methods.

RIPPLE MARKS.—In a note in *The Journal of Geology* (February–March) J. A. Udden makes some remarks on the origin of ripple marks. He concludes that in general they are due to currents in the medium of sedimentation, and that for each size of wave there is a particular depth at which the tendency for ripple marks to form is a maximum. Until this depth is reached the size of the marks varies with the depth, but beyond it the motion diminishes (cf. Kindle, *Jour. Geol.*, 1915). The optimum depth is less in sand than in silt for waves of the same dimensions. Some ripple marks may be due to the action of material transported on bottom currents, so that their size is independent of the depth, and their mode of formation analogous to that of the marks on dune-sand.

GEOLOGY.

THE ORIGIN OF THE GOLD ON THE WITWATERSRAND.—Ever since the discovery of the gold of the Rand, some thirty years ago, there has been much controversy as to the manner of its origin. The explanations put forward may be grouped under three headings, as follows: (*a*) The gold-bearing conglomerates are "fossil placers," that is, ancient alluvial gravels like the gold-bearing gravels of California, Alaska, and other countries, where the nuggets and grains of gold are derived from older rocks like the rest of the pebbles; (*b*) the gold was introduced into the gravel in solution during its formation, and there precipitated by some chemical process; or (*c*) the gold was introduced along with other substances during the cementation of the loose gravel to the present hard conglomerate. The cement is mainly iron pyrites, and the very close association that is known to exist between the gold and the pyrites has always been regarded as strong evidence in favour of the last theory. It is very rarely indeed that any gold is visible to the naked eye, and the total amount present is on the average less than one-third of an ounce to the ton of rock. The amount also varies from place to place, and

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where the same formation comes to the surface on the southern side of the basin, near Heidelberg and in the Orange Free State, the quantity of gold is too small to be profitably worked, although the conglomerate is to all appearance identical. This suggests a northern origin for the gold, and is inconsistent with the idea of precipitation of the gold known to exist in sea water, which is supposed to be uniform everywhere; at any rate, within such a short distance. In view of these difficulties, an attempt has lately been made to revive the "placer" theory. In a paper recently read before the Institute of Mining and Metallurgy Mr. E. T. Mellor states that recent work in prospecting and mining tends more and more to confirm the idea that the gold was an original constituent of the conglomerates. In any case, it is clear that there has been a good deal of recrystallisation and formation of new minerals either during or after the cementing process. Further investigations on this important subject will be awaited with much interest.

R. H. R.

THE JURASSIC PLANTS OF YORKSHIRE.—For nearly a hundred years the fossil plants from the estuarine series of north-east Yorkshire have attracted the attention of geologists and palaeobotanists. At certain places they are numerous and well preserved, and although not of such great practical importance as the plants of the Coal Measures, nevertheless they are of great scientific interest as affording a connecting link between the distinctly archaic forms of the Carboniferous and modern vegetation. The second edition of *The Geological Survey Memoir* on the country between Whitby and Scarborough, published in 1915, contains a special chapter on this flora, with a list of plants brought up to date. It is pointed out that modern critical work has considerably reduced the list of species given in the older memoirs. Some forms to which separate names were formerly given have proved to be the inflorescences of other "species"; thus the well-known fossil *Williamsonia* is now known to be the reproductive shoot of *Zamites*. The flora includes club-mosses, horsetails, ferns, cycads, conifers, ginkgoes, and possibly even a very primitive form of flowering plant. It is highly probable that further search in these strata will eventually make clear the origin and ancestry of the flowering plants of to-day.

R. H. R.

THE GENESIS OF THE DIAMOND.—The genesis of the diamond has always been a somewhat vexed question. As everyone knows, the South African diamonds occur in pipes or necks of volcanic rock known as "blue ground," or "kimberlite." This is of three kinds, derived from lava, breccia, and tuff respectively, all of which consist in the main of highly basic or ultrabasic minerals (now for the most part altered to serpentine) mingled with many xenoliths of the country rock and also of such deep-seated rocks as eclogite and granite. The diamonds are found in the pipes in crystals of all sizes from the great Cullinan, weighing one and three-quarter pounds, to fine diamond dust, and occur both in the blue ground and also in the eclogite xenoliths. The first theory put forward to account for their presence was that they had been produced by the recrystallisation of the carbon contained in shales, through which the pipes had been driven. That theory has long been abandoned, and up till lately three different hypotheses were current. These were as follows: First, that the diamonds were all of deep-seated origin, and that the pipes had only been active for a very short time, the diamonds being broken by the violence of the explosion (this is supported by the occurrence of diamonds in the eclogite); second, that they were original constituents of the kimberlite, and crystallised in place from carbon contained in solution in that rock; and third, that they were entirely secondary minerals.

In a paper in *The Mining Journal* for May, 1916, Messrs. Draper and Goodchild put forward another theory, which is to some extent a combination and amplification of all the foregoing. First of all, they suggest that the kimberlite is a product of magmatic differentiation in the pipes at the close of the activity, when the lava had ceased to flow and was not yet cooled. They then point out that, though diamonds are found in the deep-seated eclogites, they are never of large size, as are those in the blue ground. In the blue ground itself also there are found many minute diamonds. Now the diamond in these rocks is an accessory mineral in the same way as zircon and rutile; and accessory minerals are always in small crystals. Therefore the occurrence of diamonds of small size is what might reasonably be expected. The inference, therefore, is that the large stones of economic value are not original constituents of either the eclogite or the blue ground! It has been shown that at a temperature of about 1300° C. diamonds are dissolved by molten kimberlite, showing resorbed forms similar to that of quartz in porphyries in the short space of thirty minutes. There was evidently a considerable amount of solfataric action in the pipes at the close of the volcanic period, and it may well be imagined that under the influence of fluxes, such as heated water, the smaller diamonds could be dissolved by the magma and redeposited as the large stones of commerce, the phenomenon being akin to that of secondary enrichment. There are some objections to this theory, the chief being the general absence of intense metamorphism, both of the rocks surrounding the pipes and of the included fragments; but it is a very interesting addition to our ideas on this knotty subject.

W. H. W.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

AUDIBILITY OF GUN-FIRING IN FLANDERS.—At the meeting of the Royal Meteorological Society on June 21st Messrs. M. Christy and W. Marriott read a paper on the "Audibility of the Gun-firing in Flanders over the South-east of England, September, 1914–April, 1916." The sound of the fighting in Flanders has been repeatedly heard in many parts of the south-east of England since an early period of the war. The sound varies considerably: sometimes slow and deliberate firing is heard, at the rate of three to twelve shots a minute, each shot being quite loud and distinct. This is probably the firing of the monitors and other warships bombarding the German positions on the Belgian coast. Usually, however, the firing has been much more rapid, much less distinct, and apparently more distant. This is no doubt the sound of the fighting further inland, say around Ypres, Dixmude, or Arras. It varies in rapidity from perhaps four or five shots to the minute up to more than one hundred. The sound is, as a rule, quite faint, though easily perceptible and quite unmistakable. It resembles more nearly a dull and distant thud, which is rather *felt* than heard. From the records which have been collected it was shown that the gun-firing has been heard at one time or another over the counties of Essex, London, Kent, Surrey, and Sussex, the most distant places being about one hundred and fifty miles from Ypres. It appears that the meteorological conditions most favourable for the propagation of sound through the atmosphere are those when there are irregular or not very definitely defined areas of barometric pressure with a slight elevation of pressure wedged in between. There will then be light airs, or calms, at the surface, but possibly the upper currents may, however, be moving faster than the lower, and also from a slightly different direction. This is sometimes confirmed by the movements of the upper clouds and the drift of pilot balloons. Apparently a cloudy sky is more favourable for the travel of sound than a clear sky. Aspect and elevation are also very important factors.

The sound of the gun-firing during the great British advance on July 1st and 2nd was heard very distinctly over the south-east of England. It is also reported to have been heard at Avon Castle, near Ringwood, Hants, which is about two hundred miles from the firing-line.

THE STORM OF MARCH 28TH, 1916.—In the House of Commons on July 3rd the Postmaster-General, when

speaking on the Post Office Vote, gave some particulars about the damage caused by the great storm of March 28th, 1916. He said that two thousand one hundred and fifty telegraph poles were broken, six thousand one hundred and fifty uprooted, and thirty-three thousand three hundred blown over. The number of poles that had to be re-erected was forty-one thousand five hundred, not including those on the railways, which are independent of the Post Office. The copper wire broken into small fragments consisted of seventeen thousand miles in length, the whole of which had to be remelted and remanufactured, and weighed one thousand five hundred tons. The storm was the worst this country had ever experienced, and he anticipated that the damage would not be made wholly good until about next Christmas.

A discussion of this storm is being undertaken by the Meteorological Office. The Director will be glad to receive from the readers of " KNOWLEDGE " copies of any observations or other data which they may have bearing on this storm.

THE PAN-AMERICAN SCIENTIFIC CONGRESS.—At the second Pan-American Scientific Congress, which met in Washington from December 27th, 1915, to January 8th, 1916, inclusive, meteorology and seismology were represented by a sub-section of Section II. The sessions of this sub-section were held in the auditorium of the Carnegie Institution, and were attended by a considerable number of meteorologists and seismologists, as well as some of the officials of the Weather Bureau. Professor C. F. Marvin, Chief of the Weather Bureau, was the chairman, and gave an address of welcome. During the seven sessions nearly fifty papers were read. Abstracts of twenty-two of these papers are printed in *The Monthly Weather Review* for December, 1915.

CLIMATE AND HEALTH.—At the meeting of the American Climatological and Clinical Association, which was held at San Francisco in June last year, Dr. Ford A. Carpenter, of Los Angeles, read a paper on " The Physician and the Weather Bureau," in which he stated that the relation between climate and health has been recognised for at least two thousand years. In dealing with some popular misconceptions relating to climate and health, Dr. Carpenter says that the mere change in atmospheric pressure from day to day has nothing whatever to do with one's physical well-being. It is rather the fair weather and decreased humidity which accompany rising barometric pressure that elevate one's spirits, or the cloudy threatening weather and increased humidity which accompany a falling barometer that affect the human system. Dr. C. C. Browning noted this when his studies showed that the tuberculous patients became pessimistic, and some very unreasonable in their demands, during days with little or no sunshine, and hopeful of recovery during bright days and moderately low humidity. The location of the home or office, the exposure of the living or work room, has much more to do with the health of the occupant than whether or not the relative humidity is much below or above normal. Exposure to sunshine and ample ventilation are all-important. As showing how the weather map may be utilised, Dr. Carpenter says: " One of the large California citrus fruit-growers times the shipment of his orange and lemon cars so that they will have the advantage of the cool and dry weather of the weather-map ' highs ' in their eastern journey. There is no reason why a physician should not do likewise, and take advantage of the weather-map, and route his patients according to the great atmospheric movements, and thus avoid deleterious weather conditions. It ought to be a common occurrence for the physician to consult the weather bureau as to the railroad altitudes and average weather conditions along their lines, so that advantage could be taken of railroad routes having low altitudes, warm winter and cool summer weather."

THE RADIATION OF THE ATMOSPHERE.—An elaborate series of observations of the nocturnal radiation of the atmosphere was carried out by Professor A. Ångström during two expeditions — one to Algeria in 1912, the other to California in 1913 — the results of which have recently been published by the Smithsonian Institution, Washington. A special apparatus was used for these nocturnal observations. Its principal parts consist of an actinometer, to be exposed to a sky with a free horizon, a galvanometer, and a milliammeter. Among the main results and conclusions, which relate to the radiation emitted by the atmosphere to a radiating surface at a lower altitude, and to the loss of heat of a surface by radiation toward space and toward the atmosphere at higher altitudes, are the following. The variations of the total temperature radiation of the atmosphere are at low altitudes (less than fifteen thousand feet), principally caused by variations in temperature and humidity. The total radiation received from the atmosphere is very nearly proportional to the fourth power of the temperature of the place of observation. The radiation is dependent on the humidity in such a way that an increase in water-vapour content of the atmosphere will increase its radiation. An increase in the water-vapour pressure will cause a decrease in the effective radiation from the Earth to every point of the sky. The radiation of the upper dry atmosphere would be about fifty per cent. of that of a black body at the temperature of the place of observation. There is no evidence of maxima or minima of atmospheric radiation during the night that cannot be explained by the influence of temperature and humidity conditions. There are indications that the radiation during the day-time is subject to the same laws that hold for the radiation during the night-time. An increase in altitude causes a decrease or an increase in the value of the effective radiation of a blackened body toward the sky, dependent upon the value of the temperature gradient and of the humidity gradient of the atmosphere.

MICROSCOPY.

By F.R.M.S.

NOTES ON SOME PARASITIC FUNGI.—*Coeoma Mercurialis:* Figure 136 shows part of a section taken from the same material as the print which appeared in the June issue, with the exception that it shows the aecidiospores on the epidermis, their natural habitat. The former print showed the abnormal situation of the spores, whereas this is a typical example of the enlarged cluster cup formation, as exhibited in this disease generally. Relations are claimed to exist between *Melanospora aecidioides*. *Melanospora* of *Populus tremula* is also said to be the allied form of *Coeoma Mercurialis*. This particular disease attacks a great number of plants, in the case of the *Coeoma deformans* producing the " witches' brooms."

Protomyces on *Aegopodium*, or *Protomyces macrospores*. —This genus possesses septate mycelium, and shows relationship to the higher fungi, but on the whole this group shows very little close relationship with any other group. This specimen seen in Figure 137 shows the parasite on *Aegopodium*; it also attacks *Podograria Heracleum*, and so on. With regard to cultivated plants, the carrot falls a victim sometimes to its attacks. The illustration shows the mycelium and sporangium in the tissue under the epidermis. The pustule-like swellings on the epidermis of the host are indicative of the presence of the disease. Increased activity in regard to cell-division is imparted to the parenchymatous tissue following the introduction of the mycelium. The sporangia of *Protomyces* begin their activity as soon as the plant appears above ground.

Melanotaenium on *Galium*. Health versus Disease: Figure 139 is a striking instance of the deformity which shows itself when this disease attacks the plant. The *Galium* group are not, so far as is known, attacked by many parasites. In this instance *Galium Mollugo* and *G. Verum* are attacked by *Melanotaenium endogenum*. In consequence of the Galium family seeming to be immune from disease this

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particular parasitical condition is not common. The particular specimen shown was collected by Mr. E. J. Schwartz, D.Sc., of King's College, at Swanage some years back, and was photographed at a magnification of five diameters, after being preserved in spirit for some considerable time. The mycelium permeates the whole intercellular system of the host, and is nourished by tufted haustoria. As is seen in the illustration in the diseased specimen on the right, the internodes are thickened and dwarfed, and the leaves are shrunken and deformed. The reason for this may be seen when transverse sections are made of the material, the cortical tissue being filled with masses of Ustilaginae spores. The spores occur in patches in the deformed flowers, and are formed in the summer months.

Synchytrium in Potato: The section of the tuber (see Figure 138) shows the resting-stage of the spores in the cells. The starch granules in the adjoining cells are in various stages of decomposition. The disease belongs to the lower order of fungi, and is classed with such diseases as *Pythium* and *Cystopus*, and so on. It also attacks plants of *Mercurialis*, as shown attacked by *Coeoma* in Figure 136. In this case the formation of binucleate spores is found to be present.

H. C. WHITFIELD.

PHOTOGRAPHY.

By EDGAR SENIOR.

SODIUM SULPHITE IN DEVELOPERS.—The addition of sodium sulphite to the pyro developer was first suggested by the late Mr. H. B. Berkeley, in 1882, as a preventive of yellow stain in negatives, since it prevents rapid discoloration of the developer, and consequent staining of the film by the products of oxidation of the reducing agent. It was also found that by means of sodium sulphite a stock solution of pyro could be made that would keep in perfect condition for a length of time, and be ready for use whenever required. In the preparation of such a solution Mr. Berkeley recommended that forty parts of crystallised sodium sulphite should be taken and dissolved in nearly one hundred parts of distilled water, and when complete solution had taken place the sulphite—which is usually alkaline, and frequently contains carbonate as an impurity—should be nearly neutralised by means of citric acid; ten parts of pyro were then to be added, and the whole made up to one hundred parts by the further addition of distilled water. In the finished solution, "which would be a ten-per-cent. one," there would be one grain of pyro and four grains of crystallised soda sulphite in every ten minims. A preparation of this nature is prepared and sold by the Platinotype Company under the name of "Sulpho-Pyrogallol," a bottle of which, made up at least four years ago, is only now a light brown tint in colour. As well as preserving a solution of pyro in a working condition for a length of time, and preventing the staining of the gelatine film and image yellow, a plain solution of pyro containing sodium sulphite is capable, without the addition of any alkali, of developing an image on an exposed plate (Abney). It has also been found that with some of the developers their reducing action is distinctly increased by the presence of sodium sulphite. Although sulphite has this accelerating influence with some of the developers, with most the action is so slight that it need not be considered in any question regarding the quantity present in a developer. It must not, however, be forgotten that a strong solution of sodium sulphite has the power of dissolving silver bromide, and anything in a developer that does this tends to the production of general, as well as "green," fog (Lumière). For this reason it is desirable to keep the proportion of sulphite as low as possible, and it is sometimes thought that the quantity used in various developers is considerably more than is really necessary. We must not, however, assume that because a certain quantity is sufficient in a developer it will also be so in the case of a stock solution. When we come to consider the use of sulphite in preventing stain, we have to distinguish between a general staining of the whole film and that which results from the deposition of the staining matter upon the image only, with the consequent change in its colour; since it was stated by Hurter and Driffield that the only effect brought about by the presence of sulphite was an alteration in the colour of the image itself. Whether this is so or not, we know that the colour of an image is a very important factor in the printing quality of a negative. The writer has on different occasions tried variations in the quantity of sulphite in developers, with the result that when a pure black image is desired the quantity of sulphite present in a pyro-soda developer must not be less than five per cent., as with any quantity less than this the negative begins to assume a greenish hue; on the other hand, when the quantity is increased much beyond five per cent. then there is danger of fog from the solvent action of the sulphite on the silver bromide. Five per cent. of sulphite is the quantity usually present in a pyro-soda developer when ready for use, this being equivalent to twenty-four grains per ounce of developer. In actual practice it is convenient to use ten-per-cent. stock solutions, the pyro being prepared according to the method originally recommended, and the soda solution made to the following formula:—

Sodium carbonate (crystallised) ...	2 ounces (troy)
Sodium sulphite (crystallised) ...	640 grains
Water to	20 ounces

Then, if it is required to mix a developer, so that each ounce shall contain two grains of pyro and twenty-four grains of sodium sulphite, twenty minims of the ten-per-cent. pyro must be taken and made up to half an ounce by the addition of water, and lastly half an ounce of the soda solution added as well. The mixed developer will then contain:—

Pyro	2 grains
Sodium sulphite	24 ,,
Sodium carbonate	24 ,,
Water	1 ounce

Although the quantity of sulphite appears somewhat large, it is not more than is necessary if the full effect is to be obtained, as even with this amount the developer quickly becomes discoloured, and staining is not always entirely prevented. With the newer developers, however—some of which are much less liable to become discoloured by exposure to the air than pyro is—the quantity of sulphite may be considerably reduced, and in the case of amidol, so far as the prevention of stain is concerned, a two-per-cent. solution of sulphite is sufficient. The same remarks also apply to pyrocatechin, a developer which is very little discoloured by exposure to air. The following formulae, in which the quantity of sulphite differs only slightly from the amount stated, has been found to give good results in practice:—

AMIDOL DEVELOPER

Amidol	1·2 grains
Sodium sulphite	10 grains
Water to	1 ounce

PYROCATECHIN DEVELOPER.

Pyrocatechin	2 grains
Sodium sulphite	12 ,,
Caustic potash	4 ,,
Water to	1 ounce

With metol also two per cent. of sulphite is sufficient to prevent staining, unless the same solution is going to be used repeatedly, when a four-per-cent. one should be employed; but two per cent. of sulphite would not be very effective as a preservative, and, as metol works best with a large quantity of sulphite, experience has shown that six per cent. is not too much. Some economy, however, in the use of sulphite might be made by making a stock

solution of metol containing five or six per cent. of sulphite, and leaving it out entirely from the alkali. The preservative effect would in this way be gained, while the developer when mixed would contain less than the quantity often used in excess of what is really required.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

THE CHARACTER OF VIBRATIONS EMITTED BY SOURCES OF LIGHT. — In a lecture at the Royal Institution (reported in *Engineering*, March 17th, 1916) Sir J. J. Thomson referred to the problem of determining the character of the radiation emitted by a source from the results obtained in optical experiments. Until Lord Rayleigh called attention to the subject, it had been thought that the existence of interference bands necessarily implied a very great regularity in the vibrations of the body producing the light. The regularity of ordinary interference bands has nothing whatever to do with the vibrator, but depends entirely on certain peculiarities of the instrument used, or of the medium passed through by the light in the interval elapsing between its emission and its reception on the screen. An analogy taken from acoustics illustrates this view. If one stands in front of a long flight of steps the sound made by a single clap of the hands is reflected back by the steps as a prolonged echo, equivalent to a musical note of a definite pitch. This effect is due to some of the disturbance being reflected back on meeting the nearest step, but the rest of the impulse passes on until it meets the riser of the second step, from which another portion is reflected, and so on for the rest of the steps. The sound received by the ear has accordingly the character of a musical note, although it originated in a disturbance possessing nothing of this character.

INTERFERENCE WITH LARGE DIFFERENCES OF PATH.—The existence of ordinary interference bands is not a proof of any regularity in the emission of light-waves, but in the case of Michelson's experiment, in which interference occurs between rays emitted half a million periods apart, the actual regularity thus proved to exist can be explained as due to the effect of the vapour or gas by which the sources of light are surrounded. According to Sir J. J. Thomson's theory, the necessary regularity in the vibration of the sources is produced by the light itself. The light that interferes is not derived from a single luminous centre, but from a considerable number of such centres forced into phase by their mutual interaction. The stream of light in passing the atoms of the radiating gas excites them to radiate in phase with itself by fixing the time at which a particular atom begins to be luminous; the correct phase is accordingly imposed on the active atoms. As one ceases to radiate another begins, and the phase at which it starts is fixed by the stream of light in which it lies.

THE MAGNETIC HAND.—The idea of using an electromagnet flexibly attached to a leather socket to replace a lost hand is explained in an article which originally appeared in a German periodical, an abstract of which is given in *The Electrician* for June 9th, 1916. The author, by his publication, hopes to prevent patents being taken out to limit the use of such methods. For definite restricted fields of use the magnetic hand would undoubtedly be a great boon to men who had only lost one hand. The necessity of having electric power available would, however, greatly diminish its usefulness; while the fact that the energy supply is only utilised for gripping, and does not provide the work which must be done by the injured limb, still further restricts the scope of employment of such devices.

THE NOISE DUE TO THE IMPACT OF TWO SPHERES.—The cause of the characteristic click made when two balls knock together is investigated theoretically and experimentally by Banerji in a paper in *The Philosophical Magazine* for July, 1916. The distribution of the intensity of the sound in various directions round the line of direct impact is very remarkable. The intensity is a maximum in a line joining the centres, and gradually diminishes almost to zero at an angle of about 67° with a line joining the centres, when it again increases to a second maximum at an angle of 90°. The sound is not due to the vibrations of the spheres, which in any ordinary material, such as ivory, wood, or metal, are both too high in pitch to be audible, and too faint in intensity, but to air vibrations caused by the reversal of motion of the spheres as a whole.

THE ABSORPTION OF GASES IN VACUUM TUBES. —This subject has been experimentally studied by many investigators, and the apparent removal of the residual gas in a vacuum tube, when employed to carry an electric discharge, has been attributed to several possible causes. The following explanations have been given: (1) Chemical action between the gas and the glass, or (2) between the gas and the cathode; (3) chemical or mechanical action between the gas and the anode; (4) chemical action due to active nitrogen; (5) mechanical occlusion of the gas in the glass, or (6) in the cathode, or (7) in the disintegrated part of the cathode. The results of a recent research by Brodetsky and Hodgson are, on the whole, in agreement with the view that the gas is mechanically occluded in the disintegrated part of the cathode. The absorption is probably a phenomenon of some complexity. Some may be due to the liberation of the alkali metals by electrolysis of the glass and chemical combination of these metals with the gas. Willows concluded that the absorption was chemical in origin, because he found its rate to vary according to the particular nature of the glass from which the tube was made. (*Phil. Mag.*, May, 1916.)

THE PRESSURE OF SOUND-WAVES.—In an article in *Science* (May 5th, 1916) Lewis reviews various aspects of the subject of the pressure of radiation. Lord Rayleigh has shown that transverse waves in a cord exert a pressure equal to the linear energy density, and that sound-waves in the air cause a pressure equal to the volume density of the energy in the vibrating medium. Altberg has made this the basis of a method of determining the density of sounds. The pressure due to sound-waves in a gas is the result of molecular impacts, and the magnitude of the pressure is calculated by Lewis from the kinetic theory. The result is in accordance with Rayleigh's, which was obtained by a different process of reasoning. In either progressive or stationary waves there is an increased mean square velocity in the direction of the propagation, which would record itself as an increase of temperature on suitable measuring instruments. In particular at the loops of stationary sound-waves in the direction in which the waves travel there would be an increase in temperature, and a thin bolometer strip would undoubtedly indicate a higher temperature when the waves are incident on the flat side than when they are incident on its edge. Lewis computes that even when the sound is very intense the effect would be quite small.

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

CRYSTAL STRUCTURE OF THORITE.—Until recently thorite was one of the comparatively rare thorium minerals, but some years ago comparatively large quantities were found in the island of Ceylon. This mineral showed signs of being water-worn, and was generally found under much the same conditions as the more plentiful mineral thorianite. Crystalline thorite is generally regarded as having the composition $ThSiO_4$. From chemical and crystallographic analogy with zircon such crystals should be expected to belong to the tetragonal system. The

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mineral is usually classified under the zircon group. Dr. L. Vegard, of Christiania, has a long paper in the July issue of *The Philosophical Magazine*, in which he describes his examination of the structure of the minerals of the zircon group by the well-known Bragg method. In the case of thorite he found no trace of any structure at all such as characterises other minerals. This is in agreement with the results of microscopical studies of the mineral, as, for instance, when examined with polarised light. When this is done no trace is found of an optical axis, although the crystal has often perfectly sharp crystal boundaries. The explanation given of this phenomenon is that, although the mineral was definitely crystalline when it was formed, it has in the course of time become unstable. At present there is no evidence as to the cause of this instability. Different causes might be suggested, such as subsequent chemical dissociation, or the mineral having passed outside the range of temperature in which it is stable. Evidence is lacking to form an opinion on these points.

HIGH-FREQUENCY SPECTRA.—Moseley's work on this subject has been continued by Siegbahn and Friman, among others, and in the issue of *The Philosophical Magazine* mentioned in the last paragraph they give numerical data of their examination of the elements from tantalum to uranium. This series includes the radio-elements polonium, radium, thorium, and uranium. It is found that in the case of these elements, as with the lighter atons, the values obtained for the "Moseley" relation, $\sqrt{v} = a(N - No)$, show that these radio-elements fall into their expected places, and that their atomic numbers (*i.e.*, the places which they occupy when all the elements are arranged in ascending order of their atomic weights) are proved to be what they had previously been assumed. The numbers occupied by polonium, radium, thorium, and uranium are shown to be 84, 88, 90, and 92 respectively. The places 86, 89, and 91 are thus occupied by radium emanation, actinium, and uranium-X_2, or their isotopes. This means that there are still the numbers 85 and 87 which are unoccupied, and in this part of the table it is still possible that two new elements, each having unique chemical properties, may yet be discovered.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

WOODPECKER'S ANT-CATCHING DEVICE.—Mr. Harford J. Lowe has recently described an interesting piece of behaviour on the part of the green woodpecker. It made conical holes on the lawn by striking and working with its bill. Each hole served as an ant-trap for small black ants which infested the garden. The ants open "shafts" to the surface and bring out the débris of their tunnelling labours. These heaps occurring at intervals indicate the lines of the underground passages. "The woodpecker has found this out, and often makes his holes in the midst of a heap, thus entrapping the busy excavators that are moving in both directions. The bird will crouch by a trap for a considerable time, picking up the dainty morsels at leisure as they arrive."

ERRATIC MIGRATIONS OF MULLETS.—Professor Louis Roule has studied the migrations of the species of Mugil which live in the brackish water of French Mediterranean estuaries and littoral marshes. The mature individuals migrate into salt water (of higher oxygenation) to spawn. But there is also a winter migration in very cold weather, when the temperature of the marshes is very low, and this migration is exhibited by fishes of all ages. The temperature of the marshes may be three to four degrees lower than that of the adjacent sea, and freezing may take place. Similarly in the tunny (*Orcynus thynnus*) Roule distinguishes a reproductive migration in spring from an erratic individual migration in which temperature is the main factor.

CLIMBING POWERS OF CABBAGE CATERPILLARS.—Everyone knows the caterpillars of the large white butterfly (*Pieris brassicae*), and the damage they do to cabbage plants. When they are full fed and ready to pass into the pupa stage, they leave the host-plant and seek out a suitable place. Mr. R. Sharpe has recently described how they climb up under the eaves of his house by means of a rope-ladder of silk. The thread is drawn from the mouth, and by a right-to-left movement an irregular foothold, about a quarter of an inch wide, is made for the legs and claspers. A larva, one and a half inches long, was seen to make twenty-five rungs, as it were, in proceeding its own length. "The highest chrysalid is twenty-four feet six inches from the ground, so it could not have taken much less than a ladder of four thousand nine hundred rungs to reach there, requiring about one hundred and seventy yards of silk to manufacture." Upon a window-pane one hundred to one hundred and forty-five cross-strands were required for one and a half inches, and the time taken was two and a half to six minutes, as against one to one and a half minutes on the wall of the house. The higher they go, the slower they go, and the more tired they appear.

STUDY OF A DIGGER-WASP.—One of the digger-wasps (*Philanthus triangulum*) is well known in Britain as an enemy of honey-bees, which it stings under the chin. After enjoying the honey, which it squeezes out of the bee's crop by a curious kneading operation (described in detail by Fabre), it carries the body to its long burrow, and lays an egg beside it. E. L. Bouvier has added to our knowledge of the habits of this interesting insect. He has proved that the males can make burrows (apparently for protection) like the females, though not with the same success. He has also observed that in July several females may utilise one burrow. This interesting hint of sociality disappears later on when there is but one female to each burrow. The parent digger-wasps die off in autumn, and their orphaned progeny leave their cocoons about nine months afterwards.

INFECTION OF LOCUSTS WITH A VIRUS.—Various attempts have been made to infect locusts with a virus which would produce an epidemic destructive of these pests, but the success has been somewhat limited. Some recent experiments in Algiers with the American *Coccobacillus acridiorum* were distinctly disappointing. No destructive epidemic resulted. The locusts (*Schistocerca peregrina*) were found to contain two other microbes, apparently native to the region, and Dr. E. Sergent suggests that the native infection, which is not very deadly, serves as a protective "vaccination" against the American bacillus. In another part of North Africa Dr. M. Béguet was more successful. The locusts which poured northwards from the Soudan were infected at all stages by means of *Coccobacillus*, dusted on the vegetation. Paralysis and virulent diarrhoea ensued, but the mortality was not more than ten per cent. The infection passes from locust to locust in consequence of the prevalent cannibalism.

INCUBATION IN SEA-ANEMONES.—In many sea-anemones the young ones develop inside the mother until they get tentacles and numerous internal partitions dividing the body. This is the case, for instance, with *Actinia equina*, and Charles Gravier has recently called attention to the interesting fact that in tropical waters (Gulf of Guinea) the incubatory period is greatly lengthened out. The same has been noted in regard to sea-anemones from Arctic shores. But Gravier discovered a more remarkable feature. Inside the largest of the numerous young forms found inside one of the specimens of *Actinia equina* there were embryos, though there was no hint of reproductivity. The question is whether there were three generations, one within the other, the third being produced asexually; or whether the embryos were really sisters of the young form which contained them, into which they had perhaps penetrated.

XUM

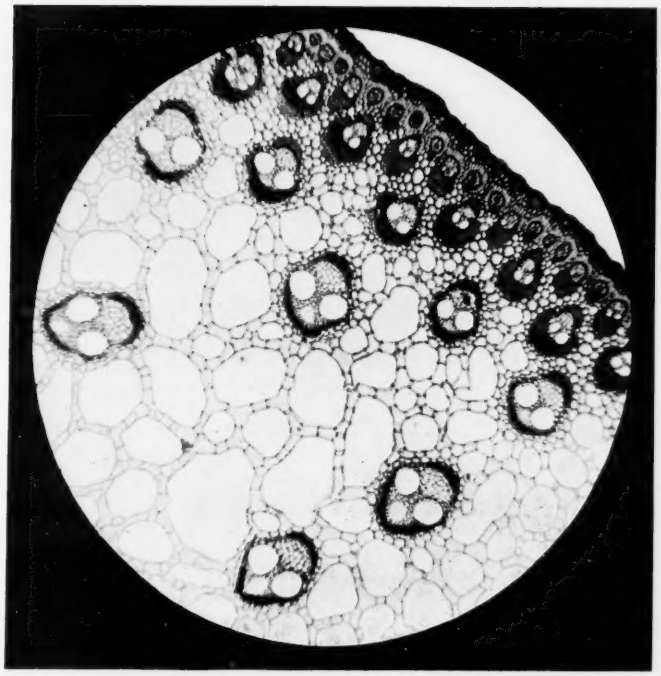

FIGURE 140. Transverse section through a Stem of Papyrus. × 45.

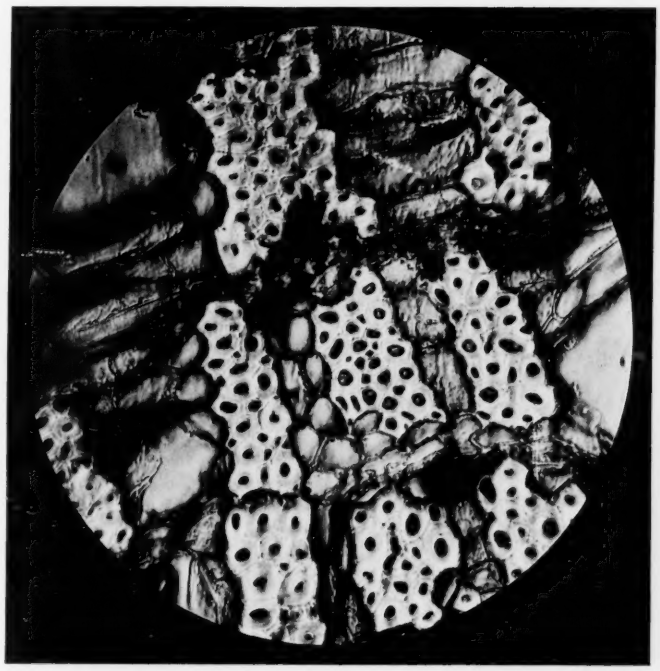

FIGURE 141. Section through the bast region of Jute Stem. × 280.

(From "Paper Making," by Cross & Bevan. By the courtesy of E. & F. N. Spon. See Page 171.)

XUM

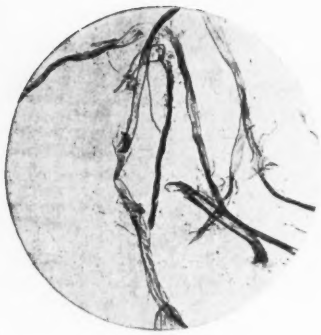

FIGURE 142.
Cotton Pulp.

FIGURE 143.
Esparto Pulp.

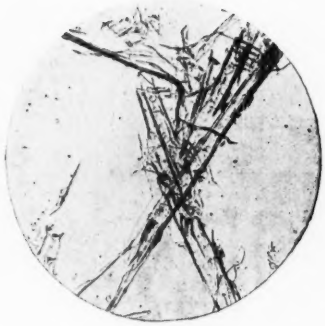

FIGURE 144.
Mechanical Wood Pulp.

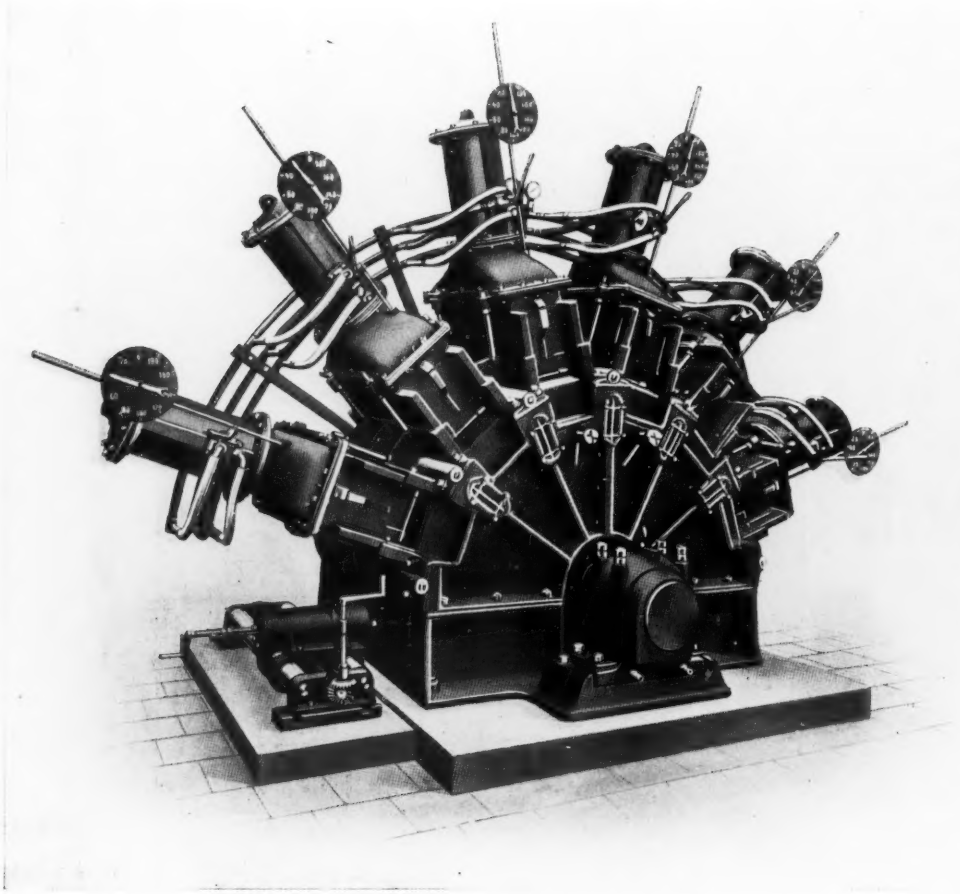

FIGURE 145. A mechanical wood-pulp Grinding Machine.

(From "Paper Making," by Cross & Bevan. By the courtesy of E. & F. N. Spon. See Page 171).

REVIEWS.

ASTRONOMY.

Dante and the Early Astronomers.—By M. A. Orr. 507 pages. 53 illustrations.

(Gall & Inglis. Price 15/- net.)

This book is divided into two parts: Pre-Dante astronomy and the astronomy of Dante's time. Part I contains eight chapters of two hundred and seven pages, and consists of a concise conspectus of astronomical ideas, preceded by a short introduction on the general movement of heavenly bodies; also a chapter on primitive astronomy—little else in those early days but astrology—from early Chinese, Egyptian, and Indian times to about 900 B.C. Then Chapters III–VIII (pages 51–205) follow, in which are given a carefully arranged historical summary of Greek, Roman, and Arabian astronomy from 900 B.C. to A.D. 1250, with several plates and figures of illustrations. When so much has been written and published on the astronomy of this period, we can hardly expect to find much that is new. The authoress has, however, widely read, not only the older books, but those containing the most recent researches, and she has not failed to make the best use of abundant material, has extracted the essence of those works, and brought the most up-to-date views to bear upon those prevailing before Dante's time; and that, too, in a concise, interesting, and absorbing manner — not merely as an assemblage of facts drawn from ancient history.

Next we come to the real object of the book, in Part II, " The Astronomy of Dante " (pages 209–496), also arranged in eight chapters. The authoress's intimate acquaintance both with Dante's books and with astronomical matters renders the use of the book a pleasure. Part II is also, not merely a collection of Dante's poetic astronomical (and astrological) references strung together, but readers are encouraged to study the precise meaning of Dante's astronomical allusions as generally accepted or understood in his day, and for the moment to assimilate his views with theirs for the better understanding and appreciation of his expressions; in reality, to banish temporarily from the mind all Copernican and Galilean astronomy. Without a familiar knowledge and clear conception of pre-Copernican astronomy the works of Dante become unreadable, or at least, we should say, unintelligible in the present-day aspect of astronomy. The authoress has admirably succeeded in the laudable attempt to provide the key to read and understand Dante's writings in this sense; and this success is evident by the frequent quotations from Dante and from contemporary astronomical authors associated with the authoress's own reasoning or connecting links; so one can read the book without weariness. Indeed, we may regard the book as an indispensable work of reference — somewhere to refer to in a moment—to be treasured and kept handy. The book should be in all good and useful libraries.

Numerous footnotes and references to books cited are given at the foot of the pages, instead of being collected at the end of the chapters; which latter method, though being more economical in printing, loses much in value by irritating readers in compelling them to turn to other pages for the authoritative reference.

The book is excellently printed, and, we are glad to say, not on plate paper. It is free from errors and is bound in durable cloth. Eleven pages are occupied with an excellent and replete index, helping to make the book a real work of reference.

F. A. B.

CHEMISTRY.

A Text Book of Paper-making.—By C. F. Cross and E. J. Bevan. Fourth Edition. 507 pages. 16 plates. 99 illustrations. 8½-in. × 5½-in.

(E. & F. N. Spon. Price 15/- net.)

Messrs. Cross and Bevan have to a considerable extent rewritten their Text Book of Paper-making, and Mr. J. F. Briggs has contributed details of sound mill practice, based upon the scientific principles which have been brought together in the volume.

Primarily the text book is for students. The raw materials used, however, which are carefully described and illustrated (see Figures 140–144) will interest the botanist. The chemist may gain much information, for Messrs. Cross and Bevan have done a great deal of original work upon cellulose, and have been at some pains to set forth its manifold combinations and properties.

The latter will appeal to the general reader, who will learn that the solution of cellulose in zinc chloride, when squirted through a fine orifice into alcohol, will produce the thread that ultimately becomes the filaments in incandescent electric lamps. A second solvent is ammoniacal cupric oxide, and this is used to compact the fibres of vegetable fabrics and paper, and to render them waterproof, as in " Willesden " goods.

Alkalis have the effect of giving a silky lustre to cotton textiles treated with them while kept under a strain. Paper plunged into sulphuric acid, and kept there for a short time, on being washed is seen to have changed its consistency and become vegetable parchment.

By treating cotton with caustic soda, and afterwards with carbon disulphide, viscose is obtained, which is now used to make artificial silk as well as for sizing papers. It can also be made into film and put to many other purposes.

Nitrates of cellulose are most important in the making of explosives and celluloid. Acetates have only recently been made commercially, and as they will stand high temperatures, they can be used successfully for kinematograph films.

We have said enough to give some idea of the uses of cellulose, and, incidentally, to show what science has been able to do for manufacturers in the case of a single substance. The text book deals with the treatment of fibres and the bleaching of them, beating, sizing, and colouring of the pulp, the actual making and finishing of the paper, paper testing, and analysis. Even the question of the best kind of site for a paper mill is discussed.

The illustrations are excellent, and include many figures of paper-making machinery (see Figure 145). They add greatly to the value of the book, which should be in every scientific man's library.

W. M. W.

Vinegar: Its Manufacture and Examination.—By C. Ainsworth Mitchell. 201 pages. 5 plates and 49 other illustrations. 7½-in. × 5-in.

(C. Griffin & Co. Price 8/6 net.)

This book deals mainly with the manufacture of vinegar, but it also contains a large amount of information about its essential constituent, acetic acid, a substance of considerable importance in the preparation of munitions of war.

The author is to be congratulated on producing a work containing much valuable information in a compact form. The historical part of his subject is treated concisely and adequately, and the illustrations well indicate the differences between old-time methods and modern practice.

The summary of the bacteriological researches connected with acetification is as complete as can be expected in a work of this nature. The details of the modern methods of manufacture are clearly expressed, and the unsatisfactory nature of the legal position of both analyst and manufacturer as regards adulteration is clearly set forth.

Mr. Mitchell has written a book which is eminently readable and which should prove of value, not only to the scientific manufacturer, but to the layman interested in matters scientific.

J. P. M.

XUM

Inks: Their Composition and Manufacture.—By C. A. MITCHELL and T. C. HEPWORTH. Second edition. 266 pages. 46 figures and 4 plates.

(C. Griffin & Co. Price 7/6 net.)

In this book the authors have given an account of inks from every point of view: historical, legal, scientific and practical. The history of the evolution of writing fluids is treated in a very interesting manner, showing the gradual development from the primitive carbon ink of the Chinese to the gall inks and other more highly specialised modern varieties which are used, not only for writing, but for a vast number of printing processes. Of special interest are the sections of the book devoted to the detection of forgeries and falsification of documents. The many excellent illustrations show clearly the application of chemical, photographic and microscopic methods in this line of work. Since the publication of the first edition, Mr. Mitchell has carried out a large amount of research, especially on the chemical side of the subject, and the results of this new and important work are here incorporated. The "get-up" of the book is good, and the illustrations clear and well chosen. The uppermost figure on Figure 54 is unfortunately reversed. The book will be welcomed by all who are interested in a subject of much difficulty and of great practical importance.

R. H. R.

PHYSICS.

Motion of Liquids.—By LIEUTENANT-COLONEL R. DE VILLAMIL, R.ENG. (RET.) 210 pages. 86 illustrations. $8\frac{1}{4}$-in. $\times 5\frac{1}{4}$-in.

(Spon. Price 6/- net.)

One of the objects of the author in writing this book is to give an account of the work of Dubuat and of Duchemin, to whose memory the work is dedicated. I have read the book with great pleasure, and can safely say that no one with any interest in the motion of liquids will regret the time spent in perusing it. Whether they will agree, or ought to agree, with all it contains is rather a different matter. But, as the author says in his preface, he does not ask the reader to accept anything without examination. The book would make an excellent present for a young student who had already studied the subject on more conventional lines.

J. H. V.

CORRESPONDENCE.

COLOUR CHANGES IN THE SUCKING-FISH.

To the Editors of "KNOWLEDGE."

SIRS,—There is a peculiarity of the sucking-fish (*Echeneis remora*) that seems to have escaped notice, at least it is not mentioned in the elementary works I have on zoölogy, but perhaps that is because they are elementary.

To begin with, shark-fishing is rather a hobby of mine, and many times when I have had a shark on the hook I have noticed sticking to it several *white* remorae. Now, after getting the shark on deck I could never find any of them, so concluded that they must have dropped off when we were hoisting the shark on board. Then several times I shot the shark before lifting him from the water to make sure that they would not be all shaken off; even then when the shark was quite dead, before attempting to lift him, and was hoisted up with the greatest care, I never could find a white remora attached to him; it was always black ones that I found. But one day I actually succeeded in getting a white one, and I was quite overjoyed, and put him very carefully on one side to give him further attention later. About a quarter of an hour after I went to gloat over my find, and was rather more than surprised to find a black one. My first thought was that someone with a perverted sense of humour had sustituted one of the black ones that had been on the shark, but I found this was not the case. Then there was only one solution left, and that was that the remora had changed his colour, so I said to myself, "Well, if he can turn black, we'll see if he can change back again." So I placed him on a white surface, and it was not long before I had the pleasure of seeing him turn to a rather dirty white, but it was *white*, nevertheless.

So I think I am justified in saying that the remorae have the power of changing their colour for protection from their enemies, or otherwise they have the gift of assuming a protective colouring at will, in common with many other fish.

But, as the remorae are mostly found attached to sharks, whales, and turtles, I think the changes would be limited between a rather brownish black and a white that had a greyish tint. The white is not the normal colour of the fish, but is the assumed one, for when the fish dies it is always of the dark colour.

CHARLES C. DIXON, F.R.MET.SOC.,
Master, Bk. "Elginshire."

AT SEA.
March 29th, 1916.

NOTICES.

MR. MURRAY'S QUARTERLY LIST.—Among Mr. Murray's forthcoming works we notice "The Life of Sir David Gill," by Professor George Forbes; "Man as he Is," being essays in a new psychology by Sir Bamfyld Fuller; "The Ages of Man," by Charles Sayle; and "British Forestry," by Edward Percy Stebbing, as well as new editions of Lock's "Recent Progress in the Study of Variation" and Thomson's "The Study of Animal Life."

BRITISH PRISONERS OF WAR.—It is more important than ever that friends and correspondents of our interned men, when writing to them, should acquaint them with the existence of an education book scheme under which they can get their wants supplied. Under this scheme any such prisoner can obtain, free of charge and carriage paid, good books of an educational character (not fiction or light literature) on almost any subject for reading or private study during his interment by communicating (either directly or through a correspondent) with Mr. A. T. Davies, of the Board of Education, Whitehall, London, S.W. Prisoners are invited to state as precisely as possible on a form (which can be had gratis on application) what kind of books they desire. The evidence that has already reached this country shows that it is necessary to provide, not merely physical, but also mental, sustenance for British prisoners during their confinement, and this the above educational book scheme aims at doing. Offers of suitable books for the latter will be gladly received by Mr. Davies, but they should be accompanied by a list of books proposed to be contributed.

THE THIRD ANNUAL CONFERENCE OF THE SOCIETY FOR PRACTICAL ASTRONOMY.—On August 24th, 25th, and 26th the third annual conference of the Society for Practical Astronomy will be held at the Bausch and Lomb Observatory in Rochester, New York. The President of the Society, Mr. Latimer J. Wilson, urges all the members to attend these sessions, and extends the invitation to anyone interested in astronomy. Papers will be read showing the important work of the Society, and addresses on optical matters and their relation to astronomical research will be given. The Bausch and Lomb Observatory is equipped with an eleven-inch refractor constructed by the Bausch and Lomb Optical Company. The conference promises to be as successful as that of last year, which was held at the University of Chicago.

XUM